



Effects of Oxygen on Exhaust CO Emissions

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OBJECTIVES



- To develop a simple yet more accurate estimate of the effects of oxygen and oxygenates on exhaust emissions of CO
- To better match model estimates to ambient CO data than current MOBILE estimates

APPROACH



- “Paired” data analysis: Analysis of data pairs in which a vehicle was tested on both a baseline, non-oxygenated fuel and a corresponding oxygenated fuel.
- Post-1981, but pre-Tier 1 data analysis conducted by Sierra Research under contract to API. Work reviewed by EPA.
- Pre-1981 effects will remain as they are in MOBILE5. Separate EPA analysis for Tier 1 & cleaner vehicles.

DATA SOURCES



- Auto/Oil--AMOT, RVP/OXY, Technology Effects Data
- EPA EF Database
- EPA RFG Study--Phase I, Phase II, and Phase III
- API RVP/Oxygenates Test Program
- CARB Low Oxygenate Gasoline Blends Test Program
- CRC Study of Winter Gasoline/Oxygenate Blends
- For Tier 1 and LEVs: Auto/Oil & CRC-Sulfur study

ANALYSIS STEPS



- Test pairs were generally selected in which the oxy blend was as close as possible to the base gasoline, with only dilution causing the other fuel parameters to differ
- Particular attention was paid to differences in RVP between the non-oxy and oxy blends (matched vs. splash blending)
- Vehicles stratified into normal and high emitter categories using 7 g/mile on a base fuel as the cut-off point

ANALYSIS STEPS



- Tier 0 (~ model years 1982-1994) effects developed as a function of emission control system
 - 1981 and later model year OXcat or open-loop TWC
 - 1981-1985 model year closed-loop TWC
 - 1986 and later model year closed-loop TWC without adaptive learning
 - 1986-1987 model year closed-loop TWC with adaptive learning
 - 1988 and later model year closed-loop TWC with adaptive learning

RESULTS FROM TIER 0 ANALYSIS



- The effect of oxygen content (wt%) on exhaust CO emission impacts is linear.
- The effect of oxygen on exhaust CO emissions will be the same at all ambient temperatures. A quantitative correction for the effect of ambient temperature on oxygen's impacts on CO emissions was difficult to determine.
- The CO emission impacts developed from FTP-composite data can be applied to both starting and running emission estimates.
- With the exception of splash blended ETOH fuels, the effect of the type of oxygenate on CO was found to be similar enough to model only oxygen content (in wt%).

RESULTS: SUMMARY OF CO EFFECTS FROM USE OF OXY FUELS FOR MATCHED RVP BLENDS AT 75 F (PRE-TIER 1)



Emitter Catg	Techlgy	CO Impact per wt% Oxy	Typical MTBE Blend (2.7 wt% O)	Typical ETOH Blend (3.5 wt% O)
Normal	1988+ TWC/ADL	-3.1 % (n=133)	-8.4 %	-10.9%
	1986-1987 TWC/ADL	-4.8% (n=104)	-13.0%	-16.8%
	1986+ TWC/no ADL	-5.7% (n=151)	-15.4%	-20.2%
	1981-1985 TWC/CL	-4.0% (n=73)	-10.8%	-14.0%
	OX/OL	-9.4%	-25.4%	-32.9%
	Non-Catalyst	-6.6%	-17.8%	-23.1%
High	1981+ TWC/CL	-5.3% (n=134)	-14.3%	-18.6%
	OX/OL	-9.4%	-25.4%	-32.9%
	Non-Catalyst	-6.6%	-17.8%	-23.1%

RESULTS FROM TIER 0 ANALYSIS



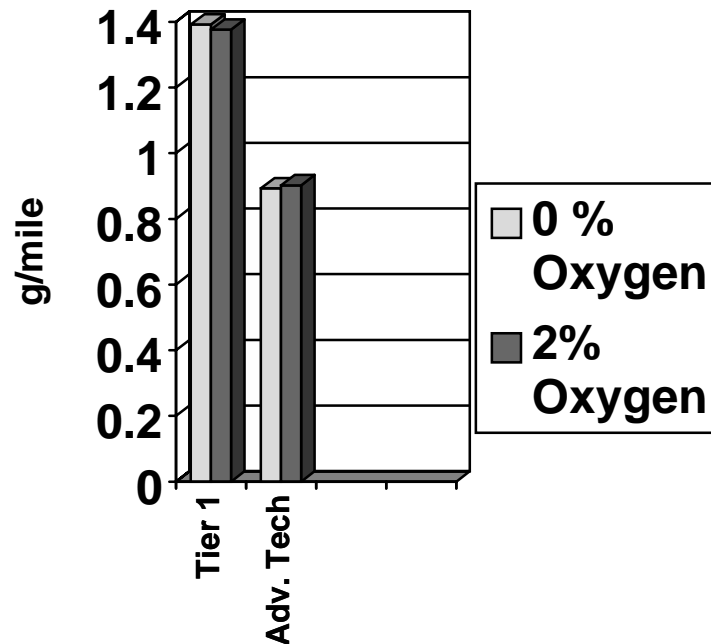
- The results in the previous table will apply for all matched RVP blends at all temperatures.
- For ethanol splash blends, the results in the previous table will be applied in tandem with the RVP flag in MOBILE6 (to offset any emission disbenefits accrued by elevated RVP levels in ETOH splash blends)

ANALYSIS AND RESULTS FOR TIER 1 AND LEV VEHICLES



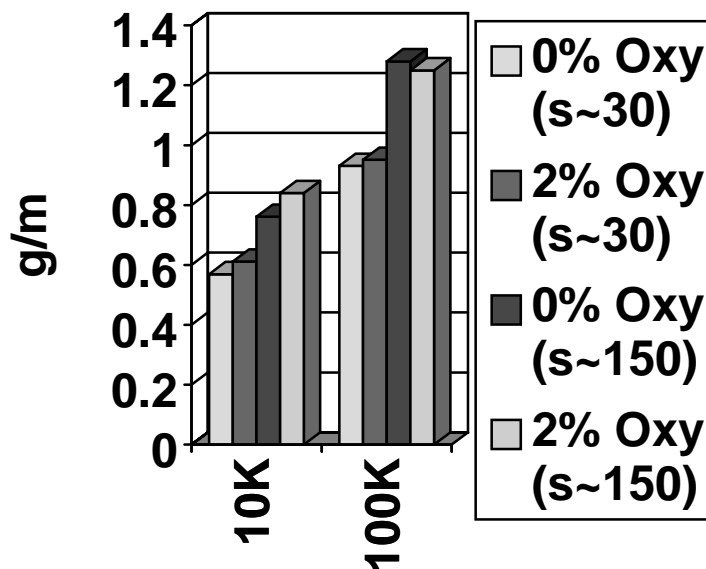
- Auto/Oil testing program included 6 certified Tier 1 vehicles and 6 prototype advanced technology vehicles (LEV-type) tested on a non-oxygenated and a oxygenated fuel
- CRC tested a total of 12 LEV vehicles. Two sets of two fuels had similar levels of sulfur (30 and 150 ppm) while being non-oxy and oxy fuels.

Average CO Emissions from Auto/Oil Testing Program



- Very small CO effects upon addition of oxygen for both sets of data
- About a 1% decrease in CO emissions for Tier 1 and a 1% increase in CO emissions for AT vehicles

Average CO Emissions from CRC Testing Program on LEVs



- Regardless of mileage or sulfur level, CO emissions generally increase slightly upon addition of oxygenate to fuel
- Thus, w/o additional data, it is concluded that oxygen's effect on CO emissions are zero.

CONCLUSIONS



- For pre-1981 MY vehicles, leave CO impacts as they currently exist in MOBILE5
- For Tier 0 vehicles (1981-1994 MYs):
 - Normal Emitters: Average 4.5% CO reduction per wt% oxygen
 - High Emitters: Average 5.3% CO reduction per wt% oxygen

CONCLUSIONS



- A nil oxy-on-CO effect will be assigned to Tier 1 and cleaner normal-emitting vehicles.
- Overall, the CO benefits of oxygen addition will decrease in MOBILE6 if the current proposals hold up. These benefits will decrease markedly in out years.